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TURNOUTS:

EXACT FORMULAE FOR THEIR DETERMINATION, TOGETHER WITH PRACTICAL AND ACCURATE TABLES FOR USE IN THE FIELD.

BY

W. B. PARSONS, Jr., C. E.,
Roadmaster N. Y. and Greenwood Lake Division, Erie Railway.

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1884.

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"TURNOUTS"

ERRATA.

Table of Contents—For Dimentions read Dimensions.

Page 1, bottom line—Read "moving," "switch," or "swing" rails.

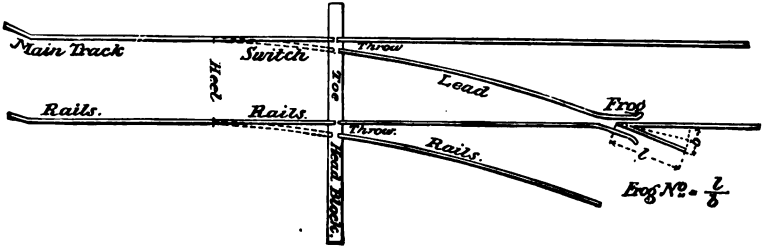
Page 9, 12th line—Read. Then $x + d$ will denote tangent deflection of chord c of curve, etc.

Table No. 1—Frog angle of Frog No. 11½, should read 4°. 58′, 45″ instead of 4°. 08′, 45″.

Page 39, top 2nd column—Read 22½ in. Centres.

TURNOUTS.

Frog Diagram.—Giving Nomenclature of Parts.



The above diagram shows the various parts of a turnout with their respective names. The length l of a frog, when used in computing the frog-number, is the length of the middle line from the *true* point to heel, shown dotted in the diagram; b is the total breadth at heel. The frog-number is equal to $\frac{l}{b}$.

"TURNOUTS"

The arrangement by which one track leaves another is called a "Turnout," and it consists of a frog, the rail leading to the frog, the opposite rail, which together are generally called "lead" rails, and some device connecting these lead rails with the main track rails. When this device is part of the lead rails and carries them out to a point of tangency on the main rails, it is called a "point" or "split" switch, but when there are two rails common to both turnout and main track, so that they can become a part of either, it is called a "stub" switch, and the common rails are variously called, "mov-ing" switch or "swing" rails. These rails at

one end rest on the head block and they are moved together by appropriate mechanism. This end is called the "toe," and the "throw" of the switch is the distance the "toe" moves on the head block when passing from main rail to that of turnout. The other end is called the "heel." The "heel" is fixed and is the origin of the turnout curve, or where it becomes tangent to the main track. The moving rail therefore forms the part of the turnout curve between the head block and origin.

The frog angle is the angle contained between the sides of the V-shaped portion, or tongue, where the main or turnout rails intersect; one side of the frog forms part of the main rail, the other part of the turnout, and is tangent to the turnout curve. The frog number is the ratio of the width of the heel of the frog to the bisecting line of the tongue.

A single-throw switch is a single turnout from main line to either right or left. A three-throw switch is a double turnout from main line to both right and left. In this case there are two frogs, which generally are of the same angle, although this is not necessary. A cross-over or crossing is a means of passing from one track to another parallel to it, and consists

of a turnout from each track and a piece connecting them between the frogs. The frogs should be of the same angle. When the parallel tracks are straight this connecting piece is also straight, but is curved when the parallel tracks are curved. In the special case however when the space between the tracks is very great the frogs may be joined together by a reversed curve of assumed radius.

The principle on which these calculations are based can be briefly stated as follows, and readily understood by reference to Fig. 1: One side of the frog is part of one of the main track rails; consider the other side prolonged until it intersects the opposite rail, and we have two lines intersecting, whose intersection angle is equal to the known frog angle. Now, the simplest arrangement to join these two lines is by a regular curve, which must by nature of the case, become tangent to one of them at the frog point. Hence, the point of the curve on one tangent is fixed, and the length of the tangent, *i. e.* the side of the frog prolonged, depends on the frog angle and gauge of track, and so of course do the other functions of the curve, as length, radius and degree. One point of tangency being at the fro

point, the other P. T. on opposite main track rail is distant from the point of intersection, the length of the tangent. This is the heel of the switch. The distance from the heel to the frog point measured on the main track, can be easily found for any frog angle and gauge of track. This distance is called the total length of lead. In the case of a "point" switch, the "toe" of the switch point is tangent to the main track rail and hence is to be placed at the heel of the switch, viz., distant from frog point the total length of lead. This is exactly true when "points" are curved, and sufficiently so when they are straight. In fact, even in the latter case it is exactly true by considering the turnout a parabola. With a stub switch it is necessary to know how much of the curve is to be required for the moving rail, or to determine location of head block. This depends on throw.

Taking a rail longer than that required by the formulæ and spiking it down, (with the exception of the necessary length for moving rail), when it is thrown, it will be found that the rail has been sprung into an arc of the turnout *curve, whose origin* is at the heel of the switch *where spiking* stopped.

Hence it is seen that the length of the lead

depends solely on the frog angle and gauge, and that the position of the head block or length of the moving rail is determined by the same considerations together with the throw.

We will take up the several cases in the following order:

Turnout from straight line.

Turnout from outside of curve.

Turnout from inside of curve.

Cross-over from straight parallel tracks.

Cross-over from curved parallel tracks.

Double turnout with equal frogs.

Double turnout with unequal frogs.

TURNOUT FROM TANGENT.

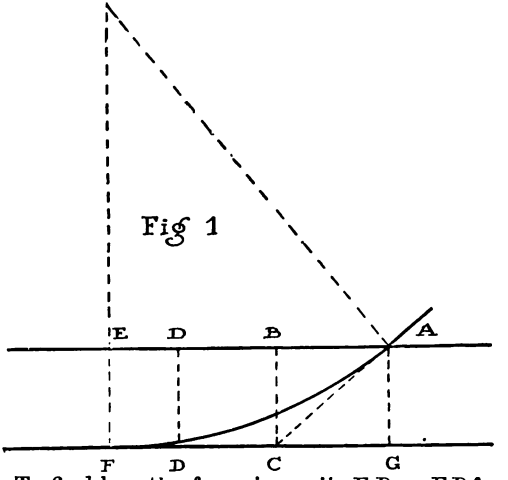
C (in Fig. 1) is point of intersection of one side of the frog prolonged and the opposite rail of main track, the intersection angle ACG evidently being equal to the given frog angle. The problem then is to join these two tangents FC and AC with a regular curve.

In triangle ABC, where angle $BAC =$ frog angle and $CB =$ gauge, find AC and AB.

AC is tangent or T; and frog angle is intersection angle, or I:

Then $R' = T \cot \frac{1}{2} I$ will give the radius of outside rail and $R = R' - \frac{1}{2}$ gauge will give the radius of turnout curve.

$AE = EB + BA = T + BA =$ distance from heel of switch rail to point of frog. (2)



To find length of moving rail, ED or FD for a given throw, *i.e.* that portion which should be left unspiked so as to be free to move, we have to calculate what length of curve is necessary to produce tangent deflection = given throw. This is done by formula.

$$C = \sqrt{\frac{d\ 50}{\sin D}} \qquad (3)$$

in which C = length of moving rail required, D = deflection angle, and d = twice throw.

Results deduced from the above formulae for various frog numbers will be found in Table No. 1.

TURNOUT FROM CURVE.

1st *Case—When frog is on outside of curve.*

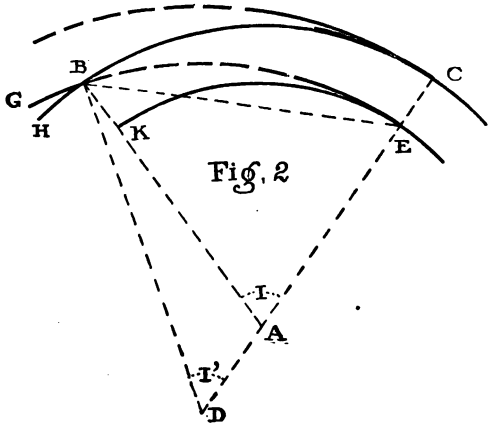


Fig. 2

Let $B\,C$ and $K\,E$ represent the outer and inner main track rails whose curve centre is A.

Let $B\,E$ represent the inner turnout rail tangent to $K\,E$ at E, the heel of the switch, and intersecting $B\,C$ at B, which is the frog point. GB and HB are tangent at the point B to $B\,E$ and $B\,C$ respectively, hence $G\,B\,H$ is the frog angle.

Draw DB perpendicular to GB, hence D is centre of turnout curve. Draw BE.

Let R denote radius of main track, and R' denote radius of turnout.

Angle GBH is the frog angle denoted by F and equals ABD.

Then in triangle ABE;

$AB + AE : AB - AE :: \tan. \frac{1}{2} (AEB + ABE) : \tan. \frac{1}{2} (AEB - ABE)$, but $AB = R + \frac{1}{2} g$ and $AE = R - \frac{1}{2} g$.

$\therefore AB + AE = 2R$, and $AB - AE = g$.

Again, $AEB = 90^\circ - \frac{1}{2} I'$, denoting angle BDE by I':

and $\quad ABE = 90^\circ - \frac{1}{2} I' - F$,

then $\frac{1}{2}$ sum $= \quad \frac{1}{2}(180^\circ - I' - F)$.

and $\frac{1}{2}$ diff. $= \quad \frac{1}{2} F$.

Denoting angle BAE by I, we have $I = I' + F$.

Substituting, $\frac{1}{2}(180 - I' - F) = 90^\circ - \frac{1}{2} I$.

Substitute, in original proportion.

$$2R : g :: \tan. (90^\circ - \tfrac{1}{2} I) : \tan. \tfrac{1}{2} F.$$

$$\tan. (90^\circ - \tfrac{1}{2} I) = \frac{2R . \tan. \frac{1}{2} F.}{g}.$$

$$\text{or, } \tan. \tfrac{1}{2} I = \frac{g}{2R \tan. \frac{1}{2} F.} \qquad (4)$$

To find length of arc BC, which gives dis-

tance from point of frog to heel of moving rail, which is origin of turnout curve,

$$\text{arc } B\ C = \frac{2\,\pi\,(R + \frac{1}{2}\,g)\,I.}{360^\circ} \qquad (5)$$

(when measured on outside rail.)

Again, $D\,B : A\,B :: \sin.\,(180^\circ - I) : \sin.\,I'$:

reducing, $D\,B = \dfrac{(R + \frac{1}{2}\,g)\,\sin.\,I}{\sin\,(I - F)}$

Radius of turnout $R' = D\,B + \frac{1}{2}\,g$

$$\text{whence } R' = \frac{(\mathrm{R} + \frac{1}{2}\,g)\,\sin.\,I}{\sin.\,(I - F)} + \frac{1}{2}\,g \qquad (6)$$

To find length of moving rail, let x denote tangent deflection of chord c_1 of turnout.

Then $x + d$ will denote tangent deflection of chord c_1 of curve, where $d =$ throw.

$$\text{But } c_1^2 = \frac{2\,x\,50}{\sin.\,D'}, \text{ and } c^2 = \frac{2\,(x + d)\,50}{\sin.\,D};$$

equating and solving we get value of x, and substituting this value in either equation we find length of c, which is length of moving rail (7)

2nd Case—When frog is on inside of curve.

The construction being similar to the previous case.

Let R, of Fig. 3, denote radius of main track, R', radius of turnout, and G B H = frog-angle $(F) = A\,B\,D$.

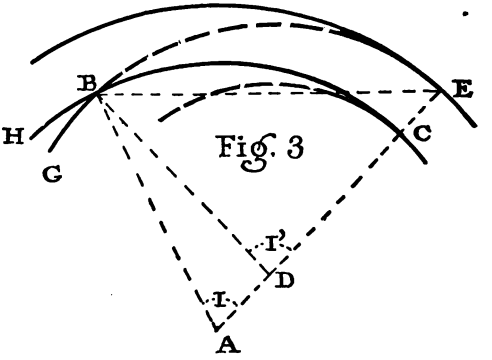


Fig. 3

Then as before;

$AE + AB : AE - AB ::$ tan. $\frac{1}{2}$ $(ABE +$
$AEB)$: tan. $\frac{1}{2}$ $(ABE - AEB)$

$AE + AB = 2R$, $AE - AB = g$

$ABE = 90^\circ - \frac{1}{2} I' + F$, $AEB = 90^\circ - \frac{1}{2} I$

substituting, $2R : g ::$ tan. $(90^\circ - \frac{1}{2} I)$: tan. $\frac{1}{2} F$

$$\text{whence tan.}\tfrac{1}{2} I = \frac{g}{2R \text{ tan. } \frac{1}{2} F} \qquad (8)$$

$$\text{arc } BC = \frac{2\pi(R - \frac{1}{2} g) I}{360^\circ} \qquad (9)$$

(when measured on inside rail.)

Again, $DB : AB : :$ sin. I : sin. $(180^\circ - I')$;

$$\text{reducing,} \quad DB = \frac{(R - \frac{1}{2} g) \sin I}{\sin (I + F)}$$

but $R' = DB - \frac{1}{2} g$.

$$\therefore R' = \frac{(R - \frac{1}{2} g) \sin. I}{\sin. (I + F)} - \frac{1}{2} g \qquad (10)$$

To find length of moving rail. In this case x will denote tangent deflection of main track, and $x+d$ the same for turnout;

$$\text{then } \overset{2}{\underset{1}{c}} = \frac{2(x+d)\,50}{\sin. D'} \text{ and } c^2 = \frac{2\,x\,50}{\sin. D} \qquad (11)$$

whence solve as before.

An examination of these equations shows: from equation 4 and 8 that the central angle is the same whether turnout is from inside or outside of curve, and from equations 5 and 9 that distance from frog point to heel of switch is also the same when measured on same rail. Now the results obtained from formulæ 4 to 11 (excepting 6 and 10) giving relations for turnouts from curves, will be found to agree practically for all ordinary cases with those obtained by formulæ for turnouts from straight line. So the figures given in Table No. 1 will answer whether turnout is from straight line, or outside or inside of curve. The question of turnout radius (eqs. 6 and 10) evidently varies with curvature of main track. From equation 6, giving value of turnout radius where frog is

on outside, it is evident that: R' is minus, that is, the turnout curves in opposite direction from main track when $F > I$, in which case R' is greater or less than R as sin. $(I - F')$ is less or greater than sin. I.

Also R' is infinity, that is, turnout is straight or tangent to main track curve when $F = I$, and R' is always greater than R when $F < I$. From equation 10, where frog is on inside, R' can never be infinity since $I + F$ cannot reduce to 0, and it must always be less than R, since sin. $(I + F)$ is always $>$ sin. I.

CROSSOVERS.

1st. *Case—When Parallel Tracks are Straight.*

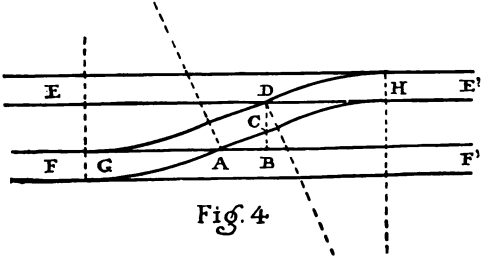


Fig. 4

Let EE' and FF' be the two parallel tracks to be joined by a crossover, the distance $(DB = d)$ between them being known. Let GH represent the crossover, with the frogs at A

and D; these frogs will have the same angle. The two parts of the crossover $A\,G$ and $D\,H$ are merely single turnouts, the various relations of which can be computed by formulæ 1 to 3, or taken directly from Table No. 1. All that remains to be found is the distance $A\,B$, or the distance between the frog-points measured on one of the parallel tracks.

Since the frogs have the same angle it is evident that the piece of track connecting the two turnouts $A\,G$ and $D\,H$ must be straight.

Therefore, $A\,B = \dfrac{B\,C}{\tan.\,F}$, where $F =$ frog-angle $B\,A\,C$.

But $B\,C = D\,B - C\,D$, in which $D\,B = d$, and $C\,D = \dfrac{g}{\cos.\,F}$; whence, by substitution

$$A\,B = d - \frac{g}{\dfrac{\cos.\,F}{\tan.\,F}} = \frac{d\cos.\,F - g}{\sin.\,F} \qquad (12)$$

2*st. Case—Where Parallel Tracks are Curved.*

Assume arrangement of tracks as shown in Fig. 5. Without going into complex calculations, the distance betweeen frog-points, *measured* midway between the two tracks.

can be taken as deduced by formula 12; this is practically true.

The crossover here is curved, the radius being $AH + \frac{1}{2}g$. Draw AB and AC. The

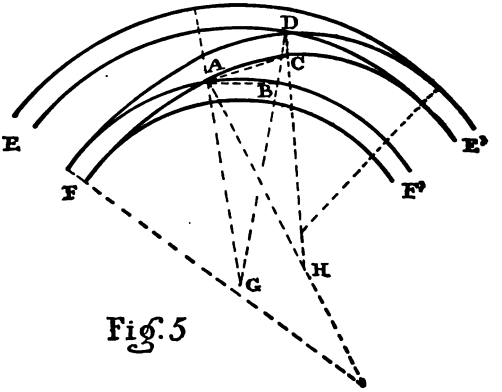


Fig. 5

triangles AGB and AHC are similar, because they are isosceles and have equal angles at the vertices G and H.

Then, $AG : HC :: AB : AC$.

But AC is greater than AB, therefore HC is greater than AG.

The radius of crossover $= HC + \frac{1}{2}g$.

The radius of inside track $= AG - \frac{1}{2}g$.

Therefore radius of crossover is greater than the radius of inside track. (13)

The turnout portions comply with previously deduced rules.

THREE-THROW SWITCHES.

1st. *Case.—When Frogs are of same angle.*

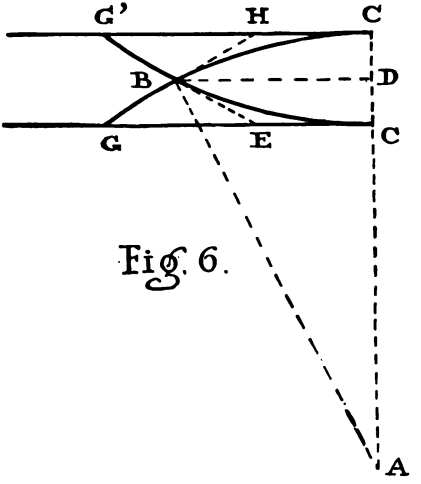


Fig. 6.

A three-throw switch is a turnout to both right and left. Let the main-track be as shown in Fig. 6, with a turnout to both right and left; the outer rails *G C* and *G' C'* intersect at *B* and are tangent to main-track rails at *C* and *C'*, so that both turnouts have their heels on the same perpendicular *A* C.

Since the frogs G and G' have the same angle the distances $G'\ C$ and $G\ C'$ are equal, and therefore the frogs are opposite each other. Each turnout follows the laws upon which formulæ 1 to 3 are based, and are worked out in Table No. 1. It therefore only remains to find the distances from point of crotch-frog at B, where the turnout-rails intersect, to either the heel of the switch or the head-block, and the crotch-frog angle.

Let R denote radius of turnout, then $A\ D = R = A\ C' - \frac{1}{2}\ g$, and $A\ B = R + \frac{1}{2}\ g$.

In the triangle $A\ B\ D$

$$B\ D = \sqrt{A\ B^2 - A\ D^2} = \sqrt{g\ (R + \tfrac{1}{4}\ g)} \qquad (14)$$

which gives the distance from heel of switch to point of crotch frog.

The distance from head-block to point of crotch frog equals $B\ D$ minus length of moving rail. (15)

The angle of the crotch frog is $E\ B\ H$, and one half the angle is $H\ B\ D = \frac{1}{2}\ F'$

$$\text{Sin. } A\ B\ D = \frac{A\ D}{A\ B} = \frac{R}{R + \frac{1}{2}\ g.};$$

but

$$H\ B\ D = 90^\circ - A\ B\ D = \tfrac{1}{2}\ F';$$

whence

$$F' = 2\,(90^\circ - A\,B\,D) = 2\left(90^\circ - \sin.^{-1}\frac{R}{R+\frac{1}{2}g.}\right)$$

$$= 2\cos.^{-1}\frac{R}{R+\frac{1}{2}g.} \qquad (16)$$

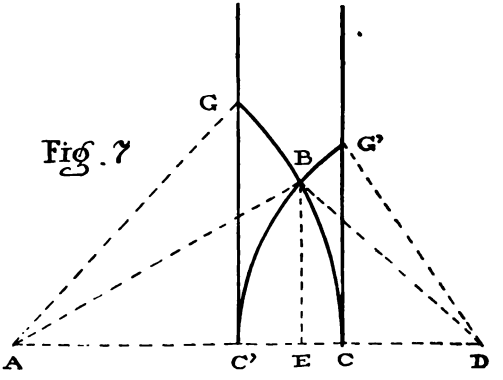
that is, the crotch frog angle equals twice the angle whose cosine is $\frac{R}{R+\frac{1}{2}g.}$

The results deduced from equations 15 and 16 for the various frogs from No. 6 to No. 13 are given in columns 9, 10 and 11 of Table No. 1. These results are practically the same whether the main track is curved or straight.

2nd Case.—When Frogs are of Different Angles.

As in the first case the two turnouts have their heels in the same line $A\,D$, but, since the frogs have different angles, the frog distances $G\,C'$ and $G'\,C$ are also different, and the frogs G and G' are no longer opposite. The crotch frog B is also no longer in the center of the main track. It is therefore necessary to know $C\,E$, or the distance the point is from the main-rail $C\,G'$ also $B\,E$ and the crotch frog angle.

In the triangle $B\ A\ D$, (Fig. 7) we know the three sides,



$A\ B$ = Radius of turnout of the left frog $+ \frac{1}{2}\ g = R' + \frac{1}{2}\ g$; $B\ D$ = Radius of turnout of the right frog $+ \frac{1}{2}\ g = R'' + \frac{1}{2}\ g$; $A\ D$ = Sum of the two radii $= R' + R''$.

Then find the angle $B\ A\ D$,

whence, $B\ E$ = sin. $B\ A\ D\ (R' + \frac{1}{2}\ g)$ **(17)**

This is the distance from heel of switch to the point of crotch frog.

$A\ E$ = cos. $B\ A\ D\ (R + \frac{1}{2}\ g)$;

but, $C\ E = A\ C - A\ E = R + \frac{1}{2}\ g -$ cos. $B\ A\ D$ $(R + \frac{1}{2}\ g) = (R + \frac{1}{2}\ g)\ (1 -$ cos. $B\ A\ D.)$ **(18)**

This gives the distance between point of *crotch frog* and opposite rail.

[redacted]

To find the angle of the crotch frog, first find the angle $A\ B\ D$, then

$$\text{Crotch frog angle} = 180^\circ - A\ B\ D. \qquad (19)$$

There is another case where instead of the heels being in the same line, some other points, as the head-blocks for instance, are in a line. The dimensions for such a combination can be most readily obtained from a carefully made scale drawing.

Description of Tables.

[*All tables are computed for a gauge of* 4 *ft.* 8½ *in.* 4.7083 ft.]

Table No 1, gives all the required data for laying out turnouts, whether single or double, and for any frog-angle. In the first column are given frog numbers increasing by halves from 5 to 13, with their corresponding angles in the second column. In the third column will be found the distance from frog-point to head-block; in the fourth, the length of the moving-rail for 5 in. "throw"; and in the fifth, the total length of "lead" from frog-point to where the turnout curve becomes tangent to the main-track, *i. e.* the "heel" of the switch. These

distances are all to be measured on the main-track. Columns 6, 7 and 8 show respectively the lengths of tangents, radii and degrees of curvature of the turnout curves. The next three columns relate to 3-throw switches; the first giving distance from point of crotch frog to head-block, and the second and third show the crotch frog angles and their corresponding numbers.

The distances which are used directly in actual measurements are given in feet and inches and are printed in heavier faced type so as to be easily found. Dimensions, such as tangent length and radius, needed for reference in future calculations are given in feet and decimals. Although this table is computed for turnouts from straight lines, yet, with the exception of those figures used in columns 6, 7 and 8, all the dimensions will be practically correct for turnouts from curves in ordinary cases.

It must be remembered that in all these tables where distances from frog-points are given it is from the *true* point. As frogs are generally blunt, the difference between the *practical* point and the *true* point must be added in each case.

is table can readily be extended in both ɔtions by noting that there is a constant ement in the values of the following:— ɜances from frog-point to head-block, length noving-rail, total length of lead and crotch g distance, for each half variation in the g number. This increment, for frog dis- nce, is 3 ft. 3¾ in. (3.31 ft.); for moving-rail, t. 4¾ in. (1.40 ft.); for total length of lead, ft. 8½ in. (4.708 ft.); and for crotch frog dis- ance, 1 ft. 11¼ in. (1.937 ft.)

In order to find the dimensions of turnouts for 3 ft. gauge, divide the above distances by their corresponding increments and multiply them by 2, 1, 3 and 1.12 respectively. This law in general is applicable to change to any other gauge, having found the increments of that gauge to multiply by.

Table No. 2—gives value of turnout radii when passing from either the inside or the outside of the curve. The left-hand vertical column gives degree of curvature of main track and the next shows whether turnout is from inside or outside of the same. The horizontal rows contain the length of the radii for these conditions, corresponding to the frog numbers *at the* top of the table.

The minus sign indicates, as explained on page 12, that the turnout curves in a reverse direction from the main-track. These minus values are printed in a heavy faced type to allow change be more readily detected.

Table No. 3—gives proper distance to locate the frog-points apart on a crossover. The horizontal row at the top gives various distances between the nearest *gauge* lines of parallel tracks. The left hand vertical column contains a series of frog numbers. The distances are to be measured on the parallel tracks.

Although computed for crossovers from straight tracks, it will be found practically correct for crossovers from curves. For convenience in using, this table is given in feet and inches.

Table No. 4—gives, at intervals of every 10 ft. from head-block measured on main-track, the ordinates of the turnout curve; that is, the distance between the main-track and outside lead-rails. By the use of this table the turnout curve can be accurately and rapidly laid out. Mark on the main-track rail, on which the frog is, every 10 ft. from the head-block, then opposite these spike down the lead-rail with

TABLE No. 3.—Distances between Frog Points on Crossovers when measured on Parallel Tracks.

Frog Number.	DISTANCES BETWEEN TRACKS.					
	ft. 7	ft. 7 in. 6	ft. 8	ft. 8 in. 3½	ft. 8 in. 6	ft. 9
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft in.
6	13 3¼	16 3	19 2¾	20 11½	22 2½	25 2¼
6½	14 5½	17 8¼	20 11	22 9½	24 1¾	27 4½
7	15 7½	19 1¼	22 7	24 7½	26 1	29 6¾
7½	16 9½	20 6½	24 3¼	26 5¼	28 0	31 8¾
8	17 11¾	21 11½	25 11¼	28 3¼	29 11	33 10¾
8½	19 1½	23 4½	27 7¼	30 1	31 10	36 1
9	20 3½	24 9½	29 3¼	31 10¾	33 9¼	38 3
9½	21 5¾	26 2½	30 11¼	33 8½	35 8¼	40 5
10	22 7½	27 7½	32 7¼	35 6¼	37 7	42 7
10½	23 9½	29 0¼	34 3¼	37 3¾	39 6	44 9
11	24 11¼	30 5¼	35 11	39 1½	41 5	46 10¾
11½	26 1¼	31 10	37 7	40 11¼	43 3¾	49 0¾
12	27 3	33 3	39 2¾	42 8¾	45 2¾	51 2½
12½	28 5	34 7¾	40 10¾	44 6½	47 1½	53 4½
13	29 7	36 0¾	42 6¾	46 4	49 0½	54 6½

the proper space between it and the main-rail as taken from the table, according to the frog number at left-hand side and distance from head-block at top. Between these points line by eye and then set the other lead-rail by gauge. The turnout curve will then be in true position and alignment.

In case it is a point switch where there is no head-block, first lay off the length of the moving rail corresponding to the frog as given in Table No. 1, and then after that the regular 10 ft. intervals. If the switch "point" is curved to the turnout radius these ordinates will fit exactly; if the "point" is straight, ordinate No. 1 may have to be forced slightly in order to conform.

A neat way to use the ordinates is to calculate them as between the rail flanges instead of gauge lines, since that gives a sharper edge to measure from. Of course distances so obtained are dependent upon the rail section.

Tables Nos. 5 to 13 give two sets of switch timbers for each frog. In the one set the ties are to be spaced forward from the head-block, at 18 in. centres, in the other at 22½ in. centres; and both are calculated to correspond with a cross tie 8 ft. long, to have their ends carry out the

Table No. 4.—Ordinates.

Frog Number.	DISTANCE, IN FEET, FROM HEAD BLOCK.															
	10 ft.		20 ft.		30 ft.		40 ft.		50 ft.		60 ft.		70 ft.		80 ft.	
	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
5	3	6	2	[illegible]	0	7¼										
5½	3	7	2	6¼	1	1¼										
6	3	7¾	2	8½	1	5¾										
6½	3	8½	2	10½	1	9½	0	5¼								
7	3	9¼	3	0¾	2	0½	0	10¼								
7½	3	9¾	3	1½	2	3	1	2½								
8	3	10	3	2¾	2	5¼	1	7¾	0	4¼						
8½	3	10¼	3	[illegible]	2	7	1	8¼	0	8½						
9	3	10¾	3	4½	2	8½	1	11	1	0						
9½	3	11	3	5¼	2	10	2	1¼	1	2	0	3¼				
10	3	11¼	3	5¾	2	11	2	3	1	5¾	0	7¼				
10½	3	11½	3	6½	3	0¼	2	4¾	1	8	0	10¼				
11	3	11¾	3	7	3	1	2	6¼	1	10¼	1	1	0	3		
11½	4	0	3	7½	3	2	2	7½	2	0	1	2½	0	4¼		
12	4	0	3	7¾	3	2¼	2	8½	2	1½	1	3¾	0	9		
12½	4	0¼	3	8¼	3	3¼	2	9	2	3	1	7¼	0	11¼	0	2¼
13	4	0½	3	8½	3	4	2	10½	2	4¼	1	9¼	1	1¼	0	4¼

turnout curve and to extend beyond the frog-point until ordinary cross ties can be put in the main track and siding without interfering. To obtain a bill of switch timber for double turnout, it is evident their number must equal those of a single turnout for same frog; and to find their lengths, add to each timber of a single turnout the amount it exceeds the standard cross tie in length.

For cross-overs the set is dependent on the distance between the tracks. With that known, the bill can readily be written out so that the cross-over and parallel tracks rest upon the same through-and-through timbers between the frog-points and for such a distance on each side of the frog-points that the turnout timbers and the cross ties of the other parallel track can be put in place separately.

To each set as given a head-block is to be added of such size as is necessary.

For "point" switches it is evident that the given tables lack the ties for the distance of the length of the moving-rail. These usually depend on the form of switch used, each type requiring special timbers in that space. All of these bills can readily be changed to correspond in length to cross ties other than 8 ft. by *adding the* difference.

Table No. 5.—Bills of Switch-Timbers for Frog No. 5.

18-*in. Centres.*			22½-*in. Centres.*		
PIECE.		LENGTH.	PIECE.		LENGTH.
1	6″ × 8″ ×	8′ 6″	1	6″ × 8″ ×	8′ 7″
1	"	8″ 8″	1	"	8′ 8″
1	"	8′ 9″	1	"	8′ 10″
1	"	8′ 11″	1	"	9′ 0″
1	"	9′ 0″	1	"	9′ 2″
1	"	9′ 2″	1	"	9′ 5″
1	"	9′ 4″	1	"	9′ 7″
1	"	9′ 6″	1	"	9′ 10″
1	"	9′ 8″	1	"	10′ 1″
1	"	9′ 10″	1	"	10′ 4″
1	"	10′ 0″	1	"	10′ 7″
1	"	10′ 3″	1	"	10′ 11″
1	"	10′ 5″	1	"	11′ 2″
1	"	10′ 8″	1	"	11′ 6″
1	"	10′ 11″	1	"	11′ 11″
1	"	11′ 2″	1	"	12′ 3″
1	"	11′ 5″	1	"	12′ 7″
1	"	11′ 8″	1	"	12′ 11″
1	"	11′ 11″	1	"	13′ 4″
1	"	12′ 3″	1	"	13′ 8″
1	"	12′ 6″	1	"	14′ 1″
1	"	12′ 9″	1	"	14′ 5″
1	"	13′ 1″	1	"	14′ 10″
1	"	13′ 5″	1	"	15′ 3″
1	"	13′ 8″	1	"	15′ 7″
1	"	14′ 0″	1	"	16′ 0″
1	"	14′ 4″			
1	"	14′ 7″	26 pieces.		304′.6″ lin.
1	"	14′ 11″			=1218 ft. B. M.
1	"	15′ 3″			
1	"	15′ 6″			
1	"	15′ 10″			
32		371′.10″ lin.			
		=1487.7 ft. B.M			

Table No. 6.—Bills of Switch Timbers Frog No. 6.

18-*in. Centres.*

Piece.		Length.
1	6″ × 8″ ×	8′ 6″
1	"	8′ 7″
1	"	8′ 8″
1	"	8′ 9″
1	"	8′ 11″
1	"	9′ 0″
1	"	9′ 1″
1	"	9′ 3″
1	"	9′ 4″
1	"	9′ 6″
1	"	9′ 8″
1	"	9′ 10″
1	"	10′ 0″
1	"	10′ 2″
1	"	10′ 4″
1	"	10′ 6″
1	"	10′ 8″
1	"	10′ 10″
1	"	11′ 1″
1	"	11′ 3″
1	"	11′ 6″
1	"	11′ 8″
1	"	11′ 11″
1	"	12′ 2″
1	"	12′ 5″
1	"	12′ 8″
1	"	12′ 11″
1	"	13′ 2″
1	"	13′ 5″
1	"	13′ 8″
1	"	13′ 11″
1	"	14′ 2″
1	"	14′ 5″
1	"	14′ 8″
1	"	14′ 11″
1	"	15′ 2″
1	"	15′ 5″
1	"	15′ 8″
1	"	15′ 11″
39		453′.8″ lin.
		= 1814.7 ft.B.M.

22½-*in. Centres.*

Piece.		Length.
1	6″ × 8″ ×	8′ 6″
1	"	8′ 8″
1	"	8′ 9″
1	"	8′ 11″
1	"	9′ 1″
1	"	9′ 2″
1	"	9′ 4″
1	"	9′ 6″
1	"	9′ 8″
1	"	9′ 11″
1	"	10′ 1″
1	"	10′ 4″
1	"	10′ 6″
1	"	10′ 9″
1	"	11′ 0″
1	"	11′ 3″
1	"	11′ 6″
1	"	11′ 10″
1	"	12′ 1″
1	"	12′ 5″
1	"	12′ 9″
1	"	13′ 0″
1	"	13′ 4″
1	"	13′ 8″
1	"	14′ 0″
1	"	14′ 4″
1	"	14′ 7″
1	"	14′ 11″
1	"	15′ 3″
1	"	15′ 7″
1	"	15′ 10″
31		360′.6″ lin
		= 1442 ft. B

Table No. 7.—Bills of Switch-Timbers for Frog No. 7.

18-*in.* *Centres.*

Piece.		Length.
1	6″ × 8″ ×	8′ 6″
1	"	8′ 7″
1	"	8′ 8″
1	"	8′ 9″
1	"	8′ 10″
1	"	8′ 11″
1	"	9′ 0″
1	"	9′ 1″
1	"	9′ 2″
1	"	9′ 4″
1	"	9′ 5″
1	"	9′ 7″
1	"	9′ 8″
1	"	9′ 10″
1	"	9′ 11″
1	"	10′ 1″
1	"	10′ 3″
1	"	10′ 4″
1	"	10′ 6″
1	"	10′ 8″
1	"	10′ 10″
1	"	11′ 0″
1	"	11′ 2″
1	"	11′ 5″
1	"	11′ 7″
1	"	11′ 9″
1	"	11′ 11″
1	"	12′ 2″
1	"	12′ 4″
1	"	12′ 7″
1	"	12′ 9″
1	"	13′ 0″
1	"	13′ 3″
1	"	13′ 5″
1	"	13′ 8″
1	"	13′ 10″
1	"	14′ 1″
1	"	14′ 4″
1	"	14′ 6″
1	"	14′ 9″
1	"	14′ 11″
1	"	15′ 2″
1	"	15′ 4″
1	"	15′ 7″
1	"	15′ 10″
45 pieces.		520′ 3″ lin.
		2081 ft. B. M.

22½-*in.* *Centres.*

Piece.		Length.
1	6″ × 8″ ×	8′ 6″
1	"	8′ 7″
1	"	8′ 8″
1	"	8′ 10″
1	"	8′ 11″
1	"	9′ 0″
1	"	9′ 2″
1	"	9′ 4″
1	"	9′ 5″
1	"	9′ 7″
1	"	9′ 9″
1	"	9′ 11″
1	"	10′ 1″
1	"	10′ 4″
1	"	10′ 6″
1	"	10′ 8″
1	"	10′ 11″
1	"	11′ 1″
1	"	11′ 4″
1	"	11′ 7″
1	"	11′ 10″
1	"	12′ 1″
1	"	12′ 4″
1	"	12′ 7″
1	"	12′ 10″
1	"	13′ 1″
1	"	13′ 5″
1	"	13′ 8″
1	"	13′ 11″
1	"	14′ 2″
1	"	14′ 6″
1	"	14′ 9″
1	"	15′ 0″
1	"	15′ 3″
1	"	15′ 6″
1	"	15′ 10″
36 pieces.		416′ 11″ lin.
		1667.7 ft. B. M

Table No. 8.—Bills of Switch Timbers of Frog No. 8.

18-in. Centres.

1	6″ × 8″ ×	8′	6″
2	"	8′	7″
1	"	8′	8″
1	"	8′	9″
1	"	8′	10″
1	"	8′	11″
1	"	9′	0″
1	"	9′	1″
1	"	9′	2″
1	"	9′	3″
1	"	9′	4″
1	"	9′	6″
1	"	9′	7″
1	"	9′	8″
1	"	9′	9″
1	"	9′	11″
1	"	10′	0″
1	"	10′	2″
1	"	10′	4″
1	"	10′	5″
1	"	10′	7″
1	"	10′	9″
1	"	10′	10″
1	"	11′	0″
1	"	11′	2″
1	"	11′	4″
1	"	11′	6″
1	"	11′	8″
1	"	11′	10″
1	"	12′	0″
1	"	12′	2″
1	"	12′	4″
1	"	12′	6″
1	"	12′	8″
1	"	12′	11″
1	"	13′	1″
1	"	13′	3″
1	"	13′	5″
1	"	13′	8″
1	"	13′	10″
1	"	14′	0″
1	"	14′	2″
1	"	14′	5″
1	"	14′	7″
1	"	14′	9″
1	"	14′	11″
1	"	15′	2″
1	"	15′	4″
1	"	15′	6″
1	"	15′	9″
1	"	15′	11″
7 pieces.		603′	0″ lin.
		2412	ft. B. M.

22½-in. Centres.

1	6″ × 8″ ×	8′	6″
1	"	8′	7″
1	"	8′	8″
1	"	8′	9″
1	"	8′	11″
1	"	9′	0″
1	"	9′	1″
1	"	9′	2″
1	"	9′	4″
1	"	9′	5″
1	"	9′	7″
1	"	9′	8″
1	"	9′	10″
1	"	10′	0″
1	"	10′	2″
1	"	10′	4″
1	"	10′	6″
1	"	10′	8″
1	"	10′	10″
1	"	11′	0″
1	"	11′	2″
1	"	11′	5″
1	"	11′	7″
1	"	11′	10″
1	"	12′	0″
1	"	12′	3″
1	"	12′	6″
1	"	12′	8″
1	"	12′	11″
1	"	13′	2″
1	"	13′	5″
1	"	13′	8″
1	"	13′	11″
1	"	14′	1″
1	"	14′	4″
1	"	14′	7″
1	"	14′	10″
1	"	15′	1″
1	"	15′	3″
1	"	15′	6″
1	"	15′	9″
1	"	16′	0″
42 pieces.		489′	11″ lin.
		1959.7	ft. B. M.

Table No. 9.—Bills of Switch-Timber for Frog No. 9.

18-*in.* *Centres.*			22½-*in.* *Centres.*		
PIECE.		LENGTH.	PIECE.		LENGTH.
2	6″ × 8″ ×	8′ 6″	1	6″ × 8″ ×	8′ 6″
1	"	8′ 7″	2	"	8′ 7″
2	"	8′ 8″	1	"	8′ 8″
1	"	8′ 9″	1	"	8′ 9″
1	"	8′ 10″	1	"	8′ 11″
1	"	3′ 11″	1	"	9′ 0″
1	"	9′ 0″	1	"	9′ 1″
1	"	9′ 1″	1	"	9′ 2″
1	"	9′ 2″	1	"	9′ 5″
1	"	9′ 3″	1	"	9′ 6″
1	"	9′ 4″	1	"	9′ 7″
1	"	9′ 5″	1	"	9′ 3″
1	"	9′ 6″	1	"	9′ 9″
1	"	9′ 7″	1	"	9′ 10″
1	"	9′ 8″	1	"	10′ 0″
1	"	9′ 10″	1	"	10′ 2″
1	"	9′ 11″	1	"	10′ 4″
1	"	10′ 0″	1	"	10′ 5″
1	"	10′ 1″	1	"	10′ 7″
1	"	10′ 3″	1	"	10′ 9″
1	"	10′ 4″	1	"	10′ 11″
1	"	10′ 6″	1	"	11′ 1″
1	"	10′ 7″	1	"	11′ 3″
1	"	10′ 9″	1	"	11′ 5″
1	"	10′ 10″	1	"	11′ 7″
1	"	11′ 0″	1	"	11′ 10″
1	"	11′ 1″	1	"	12′ 0″
1	"	11′ 3″	1	"	12′ 2″
1	"	11′ 5″	1	"	12′ 5″
1	"	11′ 6″	1	"	12′ 7″
1	"	11′ 8″	1	"	12′ 10″
1	"	11′ 10″	1	"	13′ 0″
1	"	12′ 0″	1	"	13′ 3″
1	"	12′ 2″	1	"	13′ 5″
1	"	12′ 4″	1	"	13′ 8″
1	"	12′ 6″	1	"	13′ 10″
1	"	12′ 8″	1	"	14′ 1″
1	"	12′ 10″	1	"	14′ 3″
1	"	13′ 0″	1	"	14′ 6″
1	"	13′ 2″	1	"	14′ 8″
1	"	13′ 4″	1	"	14′ 11″
1	"	13′ 6″	1	"	15′ 1″
1	"	13′ 8″	1	"	15′ 4″

(Continued on next page.)

Table No. 9.—Bills of Switch-Timber for Frog No. 9.—(*Continued.*)

18-*in.* *Centres.*		22½-*in.* *Centres.*	
PIECE.	LENGTH.	PIECE.	LENGTH.
1 "	13′ 10″	1 "	15′ 6″
1 "	14′ 0″	1 "	15′ 9″
1 "	14′ 2″	1 "	15′ 11″
1 "	14′ 4″		
1 "	14′ 6″	47 pieces.	546′ 1″ lin.
1 "	14′ 8″		2184.3 ft. B. M.
1 "	14′ 10″		
1 "	15′ 0″		
1 "	15′ 2″		
1 "	15′ 4″		
1 "	15′ 6″		
1 "	15′ 8″		
1 "	15′ 10″		
1 "	16′ 0″		
59 pieces.	686′ 3″ lin.		
	2745 ft. B. M.		

Table No. 10.—Bills of Switch-Timbers for Frog No. 10.

18-*in.* *Centres.*		22½-*in.* *Centres.*	
PIECE.	LENGTH.	PIECE.	LENGTH.
2 6″ × 8″ ×	8′ 6″	2 6″ × 8″ ×	8′ 6″
2 "	8′ 7″	1 "	8′ 7″
1 "	8′ 8″	1 "	8′ 8″
1 "	8′ 9″	1 "	8′ 9″
2 "	8′ 10″	1 "	8′ 10″
1 "	8′ 11″	1 "	8′ 11″
1 "	9′ 0″	1 "	9′ 0″
1 "	9′ 1″	1 "	9′ 1″
2 "	9′ 2″	1 "	9′ 2″
1 "	9′ 3″	1 "	9′ 3″
1 "	9′ 4″	1 "	9′ 4″
1 "	9′ 5″	1 "	9′ 6″
1 "	9′ 6″	1 "	9′ 7″
1 "	9′ 7″	1 "	9′ 8″
1 "	9′ 8″	1 "	9′ 10″
1 "	9′ 10″	1 "	9′ 11″
1 "	9′ 11″	1 "	10′ 0″
1 "	10′ 0″	1 "	10′ 2″
1 "	10′ 1″	1 "	10′ 3″

(Continued on next page.)

Table No. 10.—Bills of Switch Timbers for Frog No. 10.—(*Continued.*)

18-*in.* *Centres.*			22½-*in.* *Centres.*		
PIECE.		LENGTH	PIECE.		LENGTH.
1	"	10′ 2″	1	"	10′ 5″
1	"	10′ 3″	1	"	10′ 7″
1	"	10′ 5″	1	"	10′ 8″
1	"	10′ 6″	1	"	10′ 10″
1	"	10′ 7″	1	"	11′ 0″
1	"	10′ 9″	1	"	11′ 2″
1	"	10′ 10″	1	"	11′ 4″
1	"	10′ 11″	1	"	11′ 5″
1	"	11′ 1″	1	"	11′ 7″
1	"	11′ 2″	1	"	11′ 9″
1	"	11′ 4″	1	"	12′ 0″
1	"	11′ 5″	1	"	12′ 2″
1	"	11′ 7″	1	"	12′ 4″
1	"	11′ 9″	1	"	12′ 6″
1	"	11′ 10″	1	"	12′ 8″
1	"	12′ 0″	1	"	12′ 10″
1	"	12′ 2″	1	"	13′ 1″
1	"	12′ 3″	1	"	13′ 3″
1	"	12′ 5″	1	"	13′ 5″
1	"	12′ 7″	1	"	13′ 7″
1	"	12′ 9″	1	"	13′ 10″
1	"	12′ 10″	1	"	14′ 0″
1	"	13′ 0″	1	"	14′ 2″
1	"	13′ 2″	1	"	14′ 4″
1	"	13′ 4″	1	"	14′ 7″
1	"	13′ 6″	1	"	14′ 9″
1	"	13′ 7″	1	"	14′ 11″
1	"	13′ 9″	1	"	15′ 1″
1	"	13′ 11″	1	"	15′ 4″
1	"	14′ 0″	1	"	15′ 6″
1	"	14′ 3″	1	"	15′ 8″
1	"	14′ 4″	1	"	15′ 10″
1	"	14′ 6″	1	"	16′ 0″
1	"	14′ 8″			
1	"	14′ 10″	52 pieces.		618′.1″ lin.
1	"	15′ 0″			=2472.3 ft. B. M
1	"	15′ 1″			
1	"	15′ 3″			
1	"	15′ 5″			
1	"	15′ 7″			
1	"	15′ 9″			
1	"	15′ 10″			
1	"	16′ 0″			
48		767′.6″ lin. =3070 ft. B.M			

Table No. 11.—Bills of Switch Timbers for Frog No. 11.

18-*in.* *Centres.*			22½-*in.* *Centres.*		
PIECE.		LENGTH.	PIECE.		LENGTH.
2	6″ × 8″ ×	8′ 6″	2	6″ × 8″ ×	8′ 6″
2	"	8′ 7″	1	"	8′ 7″
2	"	8′ 8″	1	"	8′ 8″
1	"	8′ 9″	2	"	8′ 9″
2	"	8′ 10″	1	"	8′ 10″
1	"	8′ 11″	1	"	8′ 11″
1	"	9′ 0″	1	"	9′ 0″
2	"	9′ 1″	1	"	9′ 1″
1	"	9′ 2″	1	"	9′ 2″
1	"	9′ 3″	1	"	9′ 3″
1	"	9′ 4″	1	"	9′ 4″
1	"	9′ 5″	1	"	9′ 5″
1	"	9′ 6″	1	"	9′ 6″
1	"	9′ 7″	1	"	9′ 8″
1	"	9′ 8″	1	"	9′ 9″
1	"	9′ 9″	1	"	9′ 10″
1	"	9′ 10″	1	"	9′ 11″
1	"	9′ 11″	1	"	10′ 1″
1	"	10′ 0″	1	"	10′ 2″
1	"	10′ 1″	1	"	10′ 3″
1	"	10′ 2″	1	"	10′ 5″
1	"	10′ 3″	1	"	10′ 6″
1	"	10′ 4″	1	"	10′ 8″
1	"	10′ 5″	1	"	10′ 9″
1	"	10′ 6″	1	"	10′ 11″
1	"	10′ 8″	1	"	11′ 1″
1	"	10′ 9″	1	"	11′ 2″
1	"	10′ 10″	1	"	11′ 4″
1	"	10′ 11″	1	"	11′ 6″
1	"	11′ 1″	1	"	11′ 8″
1	"	11′ 2″	1	"	11′ 9″
1	"	11′ 3″	1	"	11′ 11″
1	"	11′ 5″	1	"	12′ 1″
1	"	11′ 6″	1	"	12′ 3″
1	"	11′ 8″	1	"	12′ 5″
1	"	11′ 9″	1	"	12′ 7″
1	"	11′ 11″	1	"	12′ 9″
1	"	12′ 0″	1	"	12′ 11″
1	"	12′ 2″	1	"	13′ 1″
1	"	12′ 3″	1	"	13′ 3″
1	"	12′ 5″	1	"	13′ 5″
1	"	12′ 6″	1	"	13′ 7″

(*Continued on next page.*)

Table No. 11.—Bills of Switch-Timbers for Frog No. 11.—(*Continued.*)

18-*in.* *Centres.*			22½-*in.* *Centres.*		
PIECE.		LENGTH.	PIECE.		LENGTH.
1	"	12′ 8″	1	"	13′ 9″
1	"	12′ 10″	1	"	13′ 11″
1	"	12′ 11″	1	"	14′ 2″
1	"	13′ 1″	1	"	14′ 4″
1	"	13′ 2″	1	"	14′ 6″
1	"	13′ 4″	1	"	14′ 8″
1	"	13′ 6″	1	"	14′ 10″
1	"	13′ 7″	1	"	15′ 0″
1	"	13′ 9″	1	"	15′ 2″
1	"	13′ 11″	1	"	15′ 4″
1	"	14′ 0″	1	"	15′ 6″
1	"	14′ 2″	1	"	15′ 8″
1	"	14′ 4″	1	"	15′ 10″
1	"	14′ 5″	1	"	16′ 0″
1	"	14′ 7″			
1	"	14′ 8″	58		674′.7″ lin.
1	"	14′ 10″			= 2698.3 ft. B.M.
1	"	15′ 0″			
1	"	15′ 1″			
1	"	15′ 3″			
1	"	15′ 5″			
1	"	15′ 6″			
1	"	15′ 8″			
1	"	15′ 10″			
1	"	16′ 0″			
72		834′.10″ lin.			
		=3339.3 ft.B.M.			

Table No. 12.—Bills of Switch Timbers for Frog No. 12.

18-*in. Centres.*			22½-*in. Centres.*		
PIECE.		LENGTH.	PIECE.		LENGTH.
1	6″ × 8″ ×	8′ 5″	2	6″ × 8″ ×	8′ 6″
2	"	8′ 6″	2	"	8′ 7″
2	"	8′ 7″	1	"	8′ 8″
1	"	8′ 8″	1	"	8′ 9″
2	"	8′ 9″	2	"	8′ 10″
2	"	8′ 10″	1	"	8′ 11″
1	"	8′ 11″	1	"	9′ 0″
1	"	9′ 0″	1	"	9′ 1″
2	"	9′ 1″	1	"	9′ 2″
1	"	9′ 2″	1	"	9′ 3″
1	"	9′ 3″	1	"	9′ 4″
2	"	9′ 4″	1	"	9′ 5″
1	"	9′ 5″	1	"	9′ 6″
1	"	9′ 6″	1	"	9′ 7″
1	"	9′ 7″	1	"	9′ 8″
1	"	9′ 8″	1	"	9′ 9″
1	"	9′ 9″	1	"	9′ 10″
2	"	9′ 10″	1	"	10′ 0″
1	"	9′ 11″	1	"	10′ 1″
1	"	10′ 0″	1	"	10′ 2″
1	"	10′ 1″	1	"	10′ 3″
1	"	10′ 2″	1	"	10′ 5″
1	"	10′ 3″	1	"	10′ 6″
1	"	10′ 5″	1	"	10′ 8″
1	"	10′ 6″	1	"	10′ 9″
1	"	10′ 7″	1	"	10′ 10″
1	"	10′ 8″	1	"	11′ 0″
1	"	10′ 9″	1	"	11′ 1″
1	"	10′ 10″	1	"	11′ 3″
1	"	10′ 11″	1	"	11′ 4″
1	"	11′ 0″	1	"	11′ 6″
1	"	11′ 2″	1	"	11′ 7″
1	"	11′ 3″	1	"	11′ 9″
1	"	11′ 4″	1	"	11′ 11″
1	"	11′ 5″	1	"	12′ 1″
1	"	11′ 7″	1	"	12′ 3″
1	"	11′ 8″	1	"	12′ 4″
1	"	11′ 9″	1	"	12′ 6″
1	"	11′ 11″	1	"	12′ 8″
1	"	12′ 0″	1	"	12′ 10″
1	"	12′ 2″	1	"	13′ 0″
1	"	12′ 3″	1	"	13′ 2″

(Continued on next page.)

Table No. 12.—Bills of Switch-Timbers for Frog No. 12.—(*Continued.*)

18-*in* *Centres.*

Piece.		Length.
1	"	12′ 4″
1	"	12′ 6″
1	"	12′ 7″
1	"	12′ 9″
1	"	12′ 10″
1	"	13′ 0″
1	"	13′ 1″
1	"	13′ 3″
1	"	13′ 4″
1	"	13′ 6″
1	"	13′ 7″
1	"	13′ 9″
1	"	13′ 10″
1	"	14′ 0″
1	"	14′ 1″
1	"	14′ 3″
1	"	14′ 4″
1	"	14′ 6″
1	"	14′ 7″
1	"	14′ 9″
1	"	14′ 10″
1	"	15′ 0″
1	"	15′ 1″
1	"	15′ 3″
1	"	15′ 4″
1	"	15′ 6″
1	"	15′ 7″
1	"	15′ 9″
1	"	15′ 10″
1	"	16′ 0″
79		916′.9″ lin.
		=3667 ft.B.M.

52½-*in.* *Centres.*

Piece.		Length.
1	"	13′ 4″
1	"	13′ 5″
1	"	13′ 7″
1	"	13′ 9″
1	"	13′ 11″
1	"	14′ 1″
1	"	14′ 3″
1	"	14′ 5″
1	"	14′ 7″
1	"	14′ 8″
1	"	14′ 10″
1	"	15′ 0″
1	"	15′ 2″
1	"	15′ 4″
1	"	15′ 6″
1	"	15′ 8″
1	"	15′ 10″
1	"	16′ 0″
63		731′.0″ lin.
		=2924 ft.B.M.